

Anesthesia Capacity in 22 Low and Middle Income Countries

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Abstract

Objective: A high mortality rate is associated with anesthesia in low and middle income countries. The provision of basic and emergency surgical services in developing countries includes safe anesthetic care. We sought to determine the resources available to deliver anesthesia care in low and middle income countries.

Methods: A standard World Health Organization tool was used to collect data from 34 Low and Middle-Income Countries (LMICs) regarding infrastructure and capacity of facilities. We then performed a database query to extract information on anesthesia-related capacity.

Findings: Twelve countries were excluded for providing data on less than four facilities, leaving 22 countries in our results, with a total of 590 facilities surveyed. Thirty five percent of hospitals had no access to oxygen and 40% had no anaesthesia machines; despite this, 58.5% of hospitals offered general inhalational anesthesia. All facilities reported presence of an anaesthesia provider: a nurse or clinical assistant was present in all 590 facilities. Hospitals with > 200 beds reported a range of 2-10 providers; the average number of anesthesia physicians increased from one to four as the hospital size increased from less than to greater than 300 beds. The majority of facilities were district/rural/community hospitals (34.7%), followed by health centres (23.2%), private/NGO/missions hospitals (16.6%), provincial hospitals (11.7%), and general hospitals (13.1%).

Conclusion: The delivery of anesthesia is limited by deficiencies in human resources, equipment availability and system capacity in many low and middle income countries.

Introduction

Life-saving and disability-preventive surgical procedures can only be achieved in conjunction with access to appropriate anesthesia services. Anesthesia is often perceived as only necessary at the level of secondary and tertiary health-care facilities [1] although many patients needing these services only have access to smaller, rural clinics and hospitals. Surgical and anaesthetic care continue to remain a low priority in the global health setting due to the misconception that surgical and anaesthetic care are too expensive, technologically advanced, or affect only individuals; however surgery in LMIC can be remarkably cost effective [2]. Global health resources have been monopolized by communicable disease agendas [3]. However by the year 2026, the global burden of surgical disease is projected to eclipse those of HIV, tuberculosis and malaria [4]. Increased use of motorized vehicles in LMICs without concomitant improvements in road infrastructure and trauma systems has resulted in higher mortality rates from less-severe trauma compared to those seen in high income countries [5]. There is a growing body of evidence to suggest that basic surgical treatment is cost-effective [6], and further evidence suggests that the presence of trained anaesthetists improves outcomes [7].

At present, there are shortfalls in trained personnel, infrastructure, and anaesthesia equipment. In Afghanistan (population of 32 million),

there are 9 physician anaesthetists, 8 in Bhutan (population less than 700,000), and 13 excluding expatriates in Uganda (population of 27 million). In sub-Saharan Africa the majority of anaesthetics are provided by non-physician anaesthetic providers working alone, unsupervised, and with limited training [8]. The avoidable mortality rate attributable to anaesthesia in some countries is high (1:150 in Togo, 1:504 in on Central Hospital in Malawi and 1:1923 in another in Zambia) when compared to rates of 0.55 per 100,000 in the United States [9,10].

In 2005 the WHO launched the Global Initiative for Emergency and Essential Surgical care (GIEESC), and alliance of international

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health organizations, health authorities, civil and professional societies, Non-Governmental Organizations (NGOs) and individuals committed to promoting global emergency, surgery and anesthesia care as part of primary care [11]. In 2007, GIEESC members resolved to develop an evidence-based tool (WHO Tool for Situational Analysis to Assess Emergency and Essential Surgical Care www.who.int/surgery) to identify gaps in surgical anesthetic resources in LMICs. This tool is part of the WHO Integrated Management for Emergency and Essential Surgical Care and was initially introduced jointly with WHO and Ministries of Health (MOH) in 38 LMICs. The Situational Analysis is a validated survey [12] used to collect data from various levels of care such as general, provincial, and district hospitals, NGO hospitals, and health centers.

This paper attempts to quantify these shortfalls, specifically focusing on anaesthesia resources available at the district level, utilizing the WHO Situational Analysis tool. The WHO Emergency and Essential Surgical Care (EESC) global database has been used in multiple published assessments of surgical and anesthetic capacity but the scale of facilities in single countries has not previously been queried with specific regard to anesthesia.

Methods

Data was collected by Ministries of Health, WHO country offices and by GIEESC members visiting the health facilities. No formal sampling methods were used, and the data represents a sample of convenience. These data were entered into the WHO EESC global database at WHO headquarters in Geneva, Switzerland from December 2005 through October 2010.

The WHO Tool for Situational Analysis includes 256 data points addressing hospital demographics (population served, average distance traveled, services offered), health personnel, availability of surgical and anesthetic equipment, procedures undertaken or referred and the reason for referral such as lack of skills or equipment or supplies. The equipment and supply list is based on the WHO Integrated Management for Emergency and Essential Surgical Care (IMEESC) toolkit generic Essential Emergency Equipment List.

Analysis

Countries providing assessments on less than 4 facilities were excluded from the aggregated data. Facilities included district, rural, community, provincial, or general hospitals or major health centres with a minor or major operating room and 5 or more beds. To prevent inter-country comparisons, the results were grouped for aggregate analysis. Variations between national definitions of district, provincial, and general hospitals, as well as variation between services provided made subgroup comparisons by country or hospital type impossible.

Major infrastructure items, such as oxygen, water, electricity, and functioning anaesthesia machines, were recorded as 1) always available, 2) sometimes available, or 3) not available. Management guidelines for Anaesthesia and Pain Management were recorded as available or not available. Personnel providing anaesthesia were categorised as anaesthesiologist physicians, general doctors, and nurse/clinical or assistant medical officers. Lastly, types of anaesthesia (regional, spinal, ketamine, and general inhalational) offered were recorded as performed or referred and the reason for referral (e.g. lack of skills, equipment or supplies).

Results

The IMEESC toolkit had been introduced into 34 countries at the time of this analysis. Twelve countries were excluded for providing

Country	LIC/MIC*	Number of Surveys (N=590)	Percent of Data
Indonesia	MIC	4	0.68%
Malawi	LIC	4	0.68%
Pakistan	LIC	5	0.85%
Sao Tome and Principe	LIC	5	0.85%
China	MIC	8	1.36%
Democratic Republic of the Congo	LIC	10	1.69%
Sierra Leone	LIC	11	1.86%
Ethiopia	LIC	13	2.20%
Viet Nam	LIC	18	3.05%
Ghana	LIC	21	3.56%
Liberia	LIC	22	3.73%
Niger	LIC	23	3.90%
Papua New Guinea	LIC	24	4.07%
India	LIC	25	4.24%
Afghanistan	LIC	26	4.41%
Sri Lanka	MIC	38	6.44%
Uganda	LIC	47	7.97%
United Republic of Tanzania	LIC	49	8.31%
Kenya	LIC	52	8.81%
Nigeria	LIC	54	9.15%
Mongolia	LIC	56	9.49%
Gambia	LIC	75	12.71%

*As defined by the World Bank Classification System based on 2010 GNI per capita with LIC making \$1,005 or less and MIC making \$1,006 - \$12,275

Table 1: Countries Included in Study and Number of Facilities Contributed by Each Country.

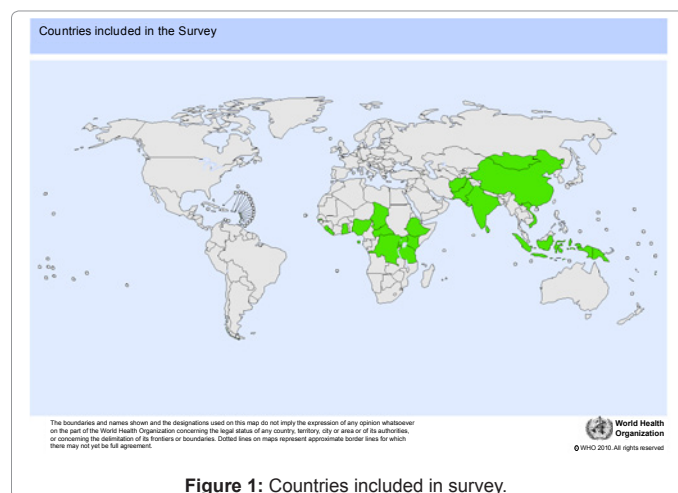


Figure 1: Countries included in survey.

data on less than four facilities, leaving 22 LMICs in our results (Table 1, Figure 1). There were a total of 590 facilities surveyed from these 22 LMICs. The majority of facilities were district/rural/community hospitals (34.7%), followed by health centres (23.2%), private/NGO/missions hospitals (16.6%), provincial hospitals (11.7%), and finally general hospitals (13.1%) as shown in Figure 2.

Infrastructure

To assess basic infrastructure we looked at availability and reliability of oxygen sources (both cylinder and concentrator), running water, and electricity (Figure 3). Each resource supply was reported as uninterrupted, interrupted, or not available. Uninterrupted water was

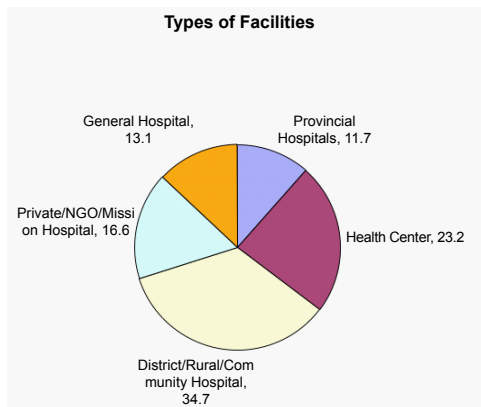


Figure 2: Of 590 facilities included in analysis, types of facilities by percentage of total.

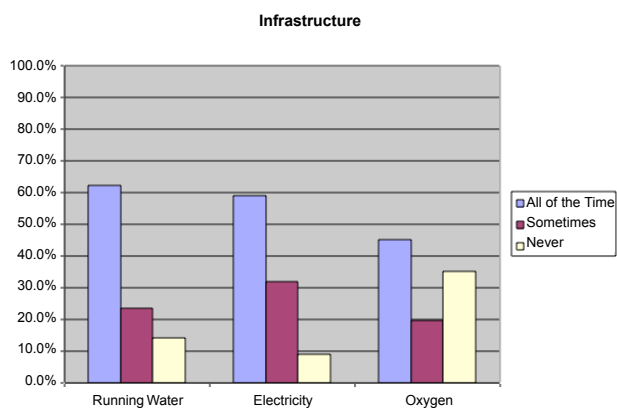


Figure 3: Availability of water, electricity and oxygen in facilities included in analysis.

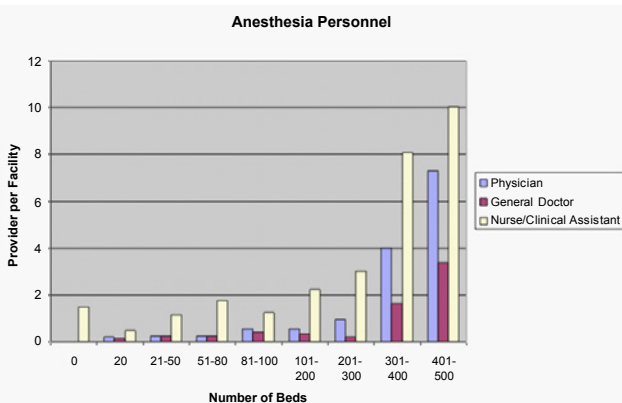


Figure 4: Personnel providing anesthesia at facilities included in analysis.

available in 62.4% of facilities surveyed. Uninterrupted electricity was available in 59% of facilities surveyed. 45.2% of facilities surveyed had uninterrupted access to oxygen either via cylinder or oxygen concentrator with 35% of facilities reporting no access to oxygen.

Personnel

Regardless of the size of facility, nurses and clinical assistants con-

stituted the majority of anesthesia providers. (Figure 4) As bed size of the facility increased to over 300 beds, the number of physician anesthesia providers increased from an average of less than one to four providers per bed; 87% (11/90) of facilities with > 300 beds were provincial and district level hospitals. Facilities were analyzed by number of beds rather than by type of facility, as the definition of 'type of facility' differs between countries and data did not fall under Gaussian or normal distribution.

Anesthesia Equipment

53.4% of facilities surveyed had reliable access to a functioning anaesthesia machine. 53% had continuous access to pulse oximetry (Figure 5a). When all facilities were examined in aggregate 21%-45% lacked

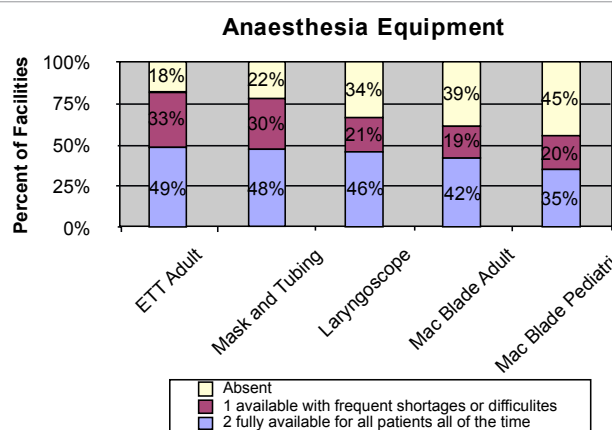


Figure 5a: Anaesthesia equipment available at facilities included in analysis.

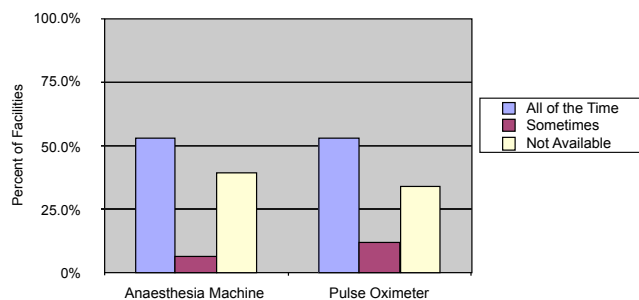


Figure 5b: Anaesthesia equipment available at facilities included in analysis.

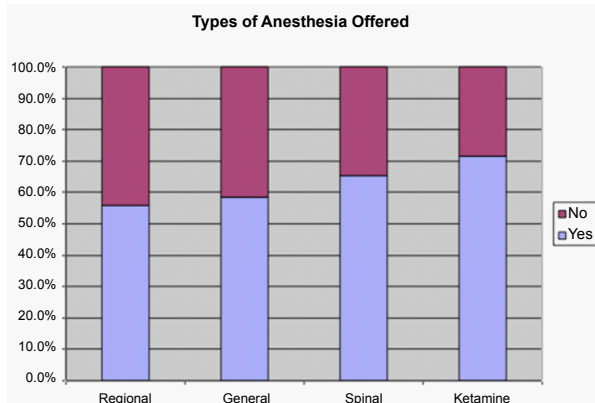


Figure 6: Type of anesthesia offered at facilities included in analysis.

basic airway management equipment such as face masks and tubing, laryngoscopes, and endotracheal tubes (Figure 5b).

Anesthesia Types Offered

Regional Anaesthesia was offered by 56% of facilities surveyed. Spinal anesthesia was offered by 65.5%. The majority of facilities had access to ketamine (71.5%). General inhalational anaesthesia was offered by 58.5% (Figure 6).

Discussion

Previous studies involving small numbers of health facilities in LMICs show overall deficiencies in basic infrastructure, personnel, equipment, and guidelines. Similar to Kushner et al findings in 2010, none of the countries in our study reported continuous supplies of uninterrupted water, electricity, or oxygen [13]. In Afghanistan, Contini et al found only 27.2% of 17 facilities surveyed had certified anaesthesiologists [14], which were dramatically higher than our percentages - however there were only 17 facilities surveyed in their study, with 11% (2/17) at the community hospital level.

These studies attempt to quantify the lack of anesthetic capacity available to LMICs and to quantify what is known a priori, that LMICs have poorer access to care than high income countries (HICs). Other studies have shown a disproportionate increase in death and disability due to these barriers [5-8,10]. What was surprising in our examination was the inherent complications to creating a global synopsis of anesthetic need; the vast variegations between countries and within countries call into question whether a checklist of essential equipment or a single top down approach to increasing anesthetic capacity is realistic.

Our analysis demonstrates that 35% of health care facilities have no access to oxygen, approximately half of facilities do not have continuous access to anesthesia machines or pulse oximetry, and that the majority of personnel providing anesthesia are nurses or clinical assistants. We recognize the significant barriers to bolstering anesthetic care in LMICs. Anesthesia requires training, functioning equipment, drugs, and disposables. Anesthesia machines must be designed to endure harsh climates, adaptation with oxygen concentrators, and interrupted power supplies. At present, it is unrealistic to expect that a trained physician anesthetist can staff every remote health care facility. Training programs should be directed through MOH's in collaboration with local professional societies and academia utilizing a two-pronged approach: parallel, immediate, and long term training programs. Task shifting through the teaching of nurses, paramedics, and medical officers to administer basic anesthetic needs at the health center or district hospital level, while staffing physician anesthetists at the secondary and tertiary care level, is a viable solution. Infrastructure and health systems should be robust enough to incentivize newly trained anaesthesiologists to stay and practice in their home countries [1].

There is a certain danger in waiting for developing countries to mature their infrastructure, primary prevention programs, and medical model before addressing surgical and anesthetic needs. There is an already widening global disparity in access to surgical and anesthetic care: there are approximately 234.2 million major operations performed annually; 74% of these occur in high and middle income countries. [15] The poorest third of the globe only receives 3.5% of all surgeries undertaken [15]. With urban migration and industrialization, the proportion of diseases affecting populations will shift from infectious diseases to non-communicable chronic illness and trauma [15]. Health

care systems will continue to be disparate, weak, and two dimensional until the same services (i.e. surgical, anaesthetic, obstetric, mental health) expected by HICs are offered to LMICs.

This study has several limitations. The data collection represents a sample of convenience. The facilities represented in the data set are not necessarily demographically or geographically representative of locality or country. Furthermore, the data was aggregated, and countries were not weighted by their contribution. In other words, a country's contribution to the data set was based on the number of completed surveys not necessarily on size, population, or health facility density which could distort the picture of global need and resources. When an error was made in survey completion an attempt was made to contact the surveyor and clarify. This was not possible in all circumstances. Even with these deficiencies, this remains the largest scale quantification of global anesthetic resources.

We challenge the common perception that anesthesia is a luxury in poor countries-at the most basic level, poor access to anesthesia is a human rights issue that requires both evidence and advocacy for saving lives.

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Disclaimer

The authors include staff members of WHO. They are responsible for the views expressed in this publication and do not necessarily represent the decisions or stated policy of WHO.

References

1. Cherian MN, Choo S, Wilson I, Noel L, Sheikh M, et al. (2010) Building and retaining the neglected anaesthesia health workforce: is it crucial for health systems strengthening through primary health care? *Bull World Health Organ* 88: 637-639.
2. Bae JY, Groen RS, Kushner AL (2011) Surgery as a public health intervention: common misconceptions versus the truth. *Bull World Health Organ* 89:394.
3. Hedges J, Mock C, Cherian MN (2010) The Political Economy of Emergency and Essential Surgery in Global Health. *World J Surg* 34: 2003-2006.
4. Jamison D (2006) World Bank Disease control priorities project. Disease control priorities in developing countries.
5. Mock C, Cherian MN (2008) The Global Burden of Musculoskeletal Injuries: Challenges and Solutions. *Clin Orthop Relat Res.* 466: 2306-2316.
6. Kushner A, Cherian MN, Noel L, Spiegel DA, Groth S, et al. (2010) Addressing the Millennium Development Goals from a Surgical Perspective. *Essential Surgery and Anaesthesia in 8 Low- and Middle- Income Countries.* *Arch Surg* 145: 154-159.
7. Debas HT, Gosselin R, McCord C, et al: Surgery. In: Jamison DT, Breman JG, Measham AR, et al (eds) *Disease control priorities in developing countries*, 2nd edn. Oxford University Press, New York, pp 1245-1260.
8. Costello A, Azad K, Barnett S (2006) An alternative strategy to reduce maternal mortality. *Lancet* 368: 1477-1479.
9. Mellin-Olsen J, Staender S, Whitaker DK, Smith AF (2010) The Helsinki Declaration on Patient Safety in Anaesthesiology. *Eur J Anaesthesiol* 27:592-597.
10. Dubowitz G, Detlefs S, McQueen KA (2010) Global Anesthesia Workforce Crisis: A Preliminary Survey Revealing Shortages Contributing to Undesirable Outcomes and Unsafe Practices. *World J Surg* 34:438-444.
11. Abdullah F, Troedsson H, Cherian M (2011) The World Health Organization Program for Emergency Surgical, Obstetric, and Anesthetic Care: From Mongolia to the Future. *Arch Surg* 146: 620-623.
12. Osen H, Chang D, Choo S, Perry H, Hesse A, et al. (2011) Validation of the World Health Organization Tool for Situational Analysis to Assess Emergency

- and Essential Surgical Care at District Hospitals in Ghana. *World J Surg* 35: 500-504.
13. Contini S, Taqdeer A, Cherian MN, Shokohmand AS, Gosselin R, et al. (2010) Emergency and Essential Surgical Services in Afghanistan: Still a Missing Challenge. *World J Surg* 34: 473-479.
 14. Weiser TG, Regenbogen S, Thompson KD, Haynes AB, Lipsitz SR, et al. (2008) An estimation of the global volume of surgery: a modeling strategy based on available data. *Lancet* 372: 139-144.
 15. Ozgediz D, Dunbar P, Mock C, Cherion M, Rogers SO Jr, et al. (2009) Bridging the gap between public health and surgery: access to surgical care in low- and middle-income countries. *Bull Am Coll Surg* 94:14-20.